TITLE: Heterogeneous Reburning by Mixed Fuels, Phase II

PI: Wei-Yin Chen

STUDENT: Benson Gathitu, Quang Shi

INSTITUTION: Department of Chemical Engineering
Anderson Hall
University of Mississippi
University, MS 38677
Phone: (662) 915-5651 Fax: (662) 915-7023
E-mail: cmchengs@olemiss.edu

SUBCONTRACTOR: Energy and Environmental Research Center, Univ. of North Dakota

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ABSTRACT

OBJEVTIVE:
The objective of the Phase II study is to bring the mixed fuel concept developed earlier to a technological fast track. This objective is achieved by simultaneously demonstrating the concept on a larger scale unit, and by acquiring additional scientific information critically needed for process optimization. Specifically, we plan to address the following issues:

1. design of mixed fuels for effective NO reduction,
2. measurements of rate constants of NO reduction on young chars,
3. construction of a semi-empirical kinetic model,
4. reaction mechanisms in burnout zone, and,
5. demonstration of the mixed fuel concept on a pilot-scale down-fired furnace.

ACCOMPLISHMENTS TO DATE:
1. By careful design of a mixed fuel and reaction conditions, total fixed nitrogen (NO, HCN and NH_3) exiting a simulating reburning reactor imply, reburning technology is likely to meet the US EPA's regulation of removing 85% of NO_x in a 3-stage reburning process. This level of NO reduction is achieved at a moderately rich reburning stoichiometric ratio 0.945. These data have been reproduced in an EERC's 7-kW boiler. A patent is pending.

2. Effective NO reductions can also be achieved by a reducing agent in the post-combustion zone in the 400 to 600°C. The process doe not involve natural gas, but yields CO.

3. A weak but cost-effective catalyst for CO oxidation has been devised and demonstrated. We are currently evaluating its technological potential.

4. Temperature-programmed desorption (TPD) of young chars demonstrates that strongly bound oxides form on the char surface at the flame temperatures; rate of char combustion is likely to be controlled by these oxides on the basal planes.

5. Commonly used alumina and SiC tube and their supporting materials participate in undesirable oxidation, reduction and decomposition reactions between 1100 and 1700°C.

FUTURE WORK:

We plan to continue the tasks discussed in the Objective section.

LIST OF PAPER, INVENTIONS AND PRESENTATIONS IN THE PAST YEAR:

Chen, W.Y., and H. Sarv, "*In-Furnace Reduction of Nitrogen Oxide by Mixed Fuels*," Provisional Patent USSN # 60/694,181, June 27, 2005.

Chen, W.Y., "*Post-Combustion Reduction of Nitrogen Oxide from Stationary and Mobile Sources*," invention disclosure to be submitted to the University of Mississippi (2006).

Chen, W.Y., and B. B. Gathitu, "*Design of Mixed Fuel for Heterogeneous Reburning*," in press, Fuel (2006).

Chen, W.Y., S. Wan, and G. Shi, "*Strong Oxides on Coal-Derived Chars and Reactions of Reactor Materials at High Temperatures*," to be submitted to Energy & Fuels (2006).

Chen, W.Y., and B. B. Gathitu, "*Heterogeneous Reburning by Mixed Fuels*," presented at the 5th International Symposium on Multiphase Flow, Heat and Mass Transfer, and Energy Conversion, Xian, China, July 3-8, 2005.

Chen, W.Y., and B. B. Gathitu, "*Post-Combustion Reduction of Nitrogen Oxide from Stationary and Mobile Sources*," presented at the Annual Meeting of the American Institute of Chemical Engineers, paper #126e, Cincinnati, Ohio, October 30 to November 4, 2005.

Chen, W.Y., "*Effective Reduction of NO for Coal-Fired Boilers by Mixed, Multi-Functional Agents*," seminar presented Donghua University, Shanghai, China, December 14, 2005.

Chen, W.Y., "*Effective Reduction of NO for Coal-Fired Boilers by Mixed, Multi-Functional Agents*," seminar presented Zhejiang University, Hangzhou, China, December 23, 2005.

Chen, W.Y., "*Effective Reduction of NO for Coal-Fired Boilers by Mixed, Multi-Functional Agents*," seminar presented Shanghai Jiaotong University, Shanghai, China, December 26, 2005.

Gathitu, B.B., and W.Y. Chen, "*Design of Reburn Fuel*," presented at the Sigma Xi Students Poster Symposium, the University of Mississippi, April 14, 2005 (**BBG won one of the three best papers award in engineering**).